

**§ 571.139 Standard No. 139; New pneumatic radial tires for light vehicles.**

**S1. Scope and purpose.** This standard specifies tire dimensions, test requirements, labeling requirements, and defines tire load ratings.

**S2 Application.** This standard applies to new pneumatic radial tires for use on motor vehicles (other than motorcycles and low speed vehicles) that have a gross vehicle weight rating (GVWR) of 10,000 pounds or less and that were manufactured after 1975. This standard does not apply to special tires (ST) for trailers in highway service, tires for use on farm implements (FI) in agricultural service with intermittent highway use, tires with rim diameters of 12 inches and below, T-type temporary use spare tires with radial construction, and light truck tires with a tread depth of 18/32 inch or greater.

**S3 Definitions.**

**Bead** means the part of the tire that is made of steel wires, wrapped or reinforced by ply cords and that is shaped to fit the rim.

**Bead separation** means a breakdown of the bond between components in the bead.

**Bias ply tire** means a pneumatic tire in which the ply cords that extend to the beads are laid at alternate angles substantially less than 90 degrees to the centerline of the tread.

**Carcass** means the tire structure, except tread and sidewall rubber which, when inflated, bears the load.

**Chunking** means the breaking away of pieces of the tread or sidewall.

**Cord** means the strands forming the plies in the tire.

**Cord separation** means the parting of cords from adjacent rubber compounds.

**Cracking** means any parting within the tread, sidewall, or inner liner of the tire extending to cord material.

**Extra load tire** means a tire designed to operate at higher loads and higher inflation pressure than the corresponding standard tire.

**Groove** means the space between two adjacent tread ribs.

**Innerliner** means the layer(s) forming the inside surface of a tubeless tire that contains the inflating medium within the tire.

**Innerliner separation** means the parting of the innerliner from cord material in the carcass.

**Light truck (LT) tire** means a tire designated by its manufacturer as primarily intended for use on lightweight trucks or multipurpose passenger vehicles.

**Load rating** means the maximum load that a tire is rated to carry for a given inflation pressure.

**Maximum load rating** means the load rating for a tire at the maximum permissible inflation pressure for that tire.

**Maximum permissible inflation pressure** means the maximum cold inflation pressure to which a tire may be inflated.

**Measuring rim** means the rim on which a tire is fitted for physical dimension requirements.

**Open splice** means any parting at any junction of tread, sidewall, or innerliner that extends to cord material.

**Outer diameter** means the overall diameter of an inflated new tire.

**Overall width** means the linear distance between the exteriors of the sidewalls of an inflated tire, including elevations due to labeling, decorations, or protective bands or ribs.

**Passenger car tire** means a tire intended for use on passenger cars, multipurpose passenger vehicles, and trucks, that have a gross vehicle weight rating (GVWR) of 10,000 pounds or less.

**Ply** means a layer of rubber-coated parallel cords.

**Ply separation** means a parting of rubber compound between adjacent plies.

**Pneumatic tire** means a mechanical device made of rubber, chemicals, fabric and steel or other materials, that, when mounted on an automotive wheel, provides the traction and contains the gas or fluid that sustains the load.

**Radial ply tire** means a pneumatic tire in which the ply cords that extend to the beads are laid at substantially 90 degrees to the centerline of the tread.

**Reinforced tire** means a tire designed to operate at higher loads and at higher inflation pressures than the corresponding standard tire.

*Rim* means a metal support for a tire or a tire and tube assembly upon which the tire beads are seated.

*Section width* means the linear distance between the exteriors of the sidewalls of an inflated tire, excluding elevations due to labeling, decoration, or protective bands.

*Sidewall* means that portion of a tire between the tread and bead.

*Sidewall separation* means the parting of the rubber compound from the cord material in the sidewall.

*Snow tire* means a tire that attains a traction index equal to or greater than 112, compared to the ASTM F2493 standard reference test tire when using the snow traction test on the medium pack snow surface as described in ASTM F1805-20 (incorporated by reference, see §571.5), and that is marked with an Alpine Symbol specified in S5.5(i) on at least one sidewall.

*Test rim* means the rim on which a tire is fitted for testing, and may be any rim listed as appropriate for use with that tire.

*Tread* means that portion of a tire that comes into contact with the road.

*Tread rib* means a tread section running circumferentially around a tire.

*Tread separation* means pulling away of the tread from the tire carcass.

*Treadwear indicators (TWI)* means the projections within the principal grooves designed to give a visual indication of the degrees of wear of the tread.

*Wheel-holding fixture* means the fixture used to hold the wheel and tire assembly securely during testing.

**S4. Tire and rim matching information.**

S4.1. Each manufacturer of tires must ensure that a listing of the rims that may be used with each tire that it produces is provided to the public in accordance with S4.1.1 and S4.1.2.

S4.1.1 Each rim listing for a tire must include dimensional specifications and a diagram of the rim and must be in one of the following forms:

(a) Listed by manufacturer name or brand name in a document furnished to dealers of the manufacturer's tires, to any person upon request, and in duplicate to the Docket Section (No. NHTSA-2009-0117), National Highway Traffic Safety Administration, West

Building, 1200 New Jersey Ave. SE, Washington, DC 20590; or

(b) Contained in publications, current at the date of manufacture of the tire or any later date, of at least one of the following organizations:

(1) The Tire and Rim Association.

(2) The European Tyre and Rim Technical Organization.

(3) Japan Automobile Tire Manufacturers' Association, Inc.

(4) Tyre & Rim Association of Australia.

(5) Associacao Latino Americana de Pneus e Aros (Brazil).

(6) South African Bureau of Standards.

S4.1.2 A listing compiled in accordance with paragraph (a) of S4.1.1 need not include dimensional specifications or a diagram of a rim whose dimensional specifications and diagram are contained in a listing published in accordance with paragraph (b) of S4.1.1.

S4.2. Information contained in a publication specified in S4.1.1(b) that lists general categories of tires and rims by size designation, type of construction, and/or intended use, is considered to be manufacturer's information required by S4.1 for the listed tires, unless the publication itself or specific information provided according to S4.1(a) indicates otherwise.

**S5. General requirements**

S5.1. *Size and construction.* Each tire shall fit each rim specified for its size designation in accordance with S4.1.

S5.2. *Performance requirements.* Each tire shall conform to each of the following:

(a) It shall meet the requirements specified in S6 for its tire size designation, type, and maximum permissible inflation pressure.

(b) It shall meet each of the applicable requirements set forth in paragraphs (c) and (d) of this S5.2, when mounted on a model rim assembly corresponding to any rim designated by the tire manufacturer for use with the tire in accordance with S4.

(c) Its maximum permissible inflation pressure shall be 240, 280, 300, 340, or 350 kPa.

(d) Its load rating shall be that specified either in a submission made by an individual manufacturer, pursuant to

S4, or in one of the publications described in S4 for its size designation, type and each appropriate inflation pressure. If the maximum load rating for a particular tire size is shown in more than one of the publications described in S4, each tire of that size designation shall have a maximum load rating that is not less than the published maximum load rating, or if there are differing maximum load ratings for the same tire size designation, not less than the lowest published maximum load rating.

S5.3. *Test sample.* For the tests specified in S6, use:

- (a) One tire for high speed;
- (b) Another tire for endurance and low inflation pressure performance; and
- (c) A third tire for physical dimensions, resistance to bead unseating, and strength, in sequence.

S5.4. *Treadwear indicators.* Except in the case of tires with a 12-inch or smaller rim diameter, each tire shall have not less than six treadwear indicators spaced approximately equally around the circumference of the tire that enable a person inspecting the tire to determine visually whether the tire has worn to a tread depth of one sixteenth of an inch. Tires with 12-inch or smaller rim diameter shall have not less than three such treadwear indicators.

S5.5. *Tire markings.* Except as specified in paragraphs (a) through (i) of S5.5, each tire must be marked on each sidewall with the information specified in S5.5(a) through (d) and on one sidewall with the information specified in S5.5(e) through (i) according to the phase-in schedule specified in S7 of this standard. The markings must be placed between the maximum section width and the bead on at least one sidewall, unless the maximum section width of the tire is located in an area that is not more than one-fourth of the distance from the bead to the shoulder of the tire. If the maximum section width falls within that area, those markings must appear between the bead and a point one-half the distance from the bead to the shoulder of the tire, on at least one sidewall. The markings must be in letters and numerals not less than 0.078 inches high and raised above

or sunk below the tire surface not less than 0.015 inches.

(a) The symbol DOT, which constitutes a certification that the tire conforms to applicable Federal motor vehicle safety standards;

(b) The tire size designation as listed in the documents and publications specified in S4.1.1 of this standard;

(c) The maximum permissible inflation pressure, subject to the limitations of S5.5.4 through S5.5.6 of this standard;

(d) The maximum load rating and for LT tires, the letter designating the tire load range;

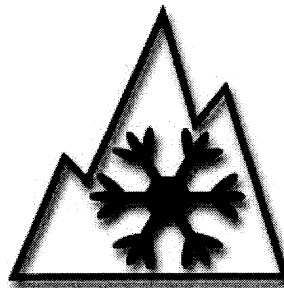
(e) The generic name of each cord material used in the plies (both sidewall and tread area) of the tire;

(f) The actual number of plies in the sidewall, and the actual number of plies in the tread area, if different;

(g) The term “tubeless” or “tube type,” as applicable;

(h) The word “radial,” if the tire is a radial ply tire; and

(i) *Alpine Symbol.* A tire meeting the definition of a snow tire as defined in paragraph S3 may, at the option of the manufacturer, show the pictograph of a mountain with a snowflake as shown below. If the manufacturer chooses to mark the snow tire with the alpine symbol, the mountain profile must have a minimum base of 15 mm and a minimum height of 15 mm, and must contain three peaks with the middle peak being the tallest. Inside the mountain, there must be a six-sided snowflake having a minimum height of one-half the tallest peak.



S5.5.1 *Tire identification number.*

(a) *Tires manufactured before September 1, 2009.* Each tire must be labeled with the tire identification number required by 49 CFR part 574 on a sidewall

of the tire. Except for retreaded tires, either the tire identification number or a partial tire identification number, containing all characters in the tire identification number, except for the date code and, at the discretion of the manufacturer, any optional code, must be labeled on the other sidewall of the tire.

(b) *Tires manufactured on or after September 1, 2009.* Each tire must be labeled with the tire identification number required by 49 CFR part 574 on the intended outboard sidewall of the tire. Except for retreaded tires, either the tire identification number or a partial tire identification number, containing all characters in the tire identification number, except for the date code and, at the discretion of the manufacturer, any optional code, must be labeled on the other sidewall of the tire. Except for retreaded tires, if a tire does not have an intended outboard sidewall, the tire must be labeled with the tire identification number required by 49 CFR part 574 on one sidewall and with either the tire identification number or a partial tire identification number, containing all characters in the tire identification number except for the date code and, at the discretion of the manufacturer, any optional code, on the other sidewall.

S5.5.2 [Reserved]

S5.5.3 Each tire must be labeled with the name of the manufacturer, or brand name and number assigned to the manufacturer in the manner specified in 49 CFR part 574.

S5.5.4 For passenger car tires, if the maximum inflation pressure of a tire is 240, 280, 300, 340, or 350 kPa, then:

(a) Each marking of that inflation pressure pursuant to S5.5(c) must be followed in parenthesis by the equivalent psi, rounded to the next higher whole number; and

(b) Each marking of the tire's maximum load rating pursuant to S5.5(d) in kilograms must be followed in parenthesis by the equivalent load rating in pounds, rounded to the nearest whole number.

S5.5.5 If the maximum inflation pressure of a tire is 420 kPa (60 psi), the tire must have permanently molded into or onto both sidewalls, in letters and numerals not less than ½ inch

high, the words "Inflate to 60 psi" or "Inflate to 420 kPa (60 psi)." On both sidewalls, the words must be positioned in an area between the tire shoulder and the bead of the tire. However, the words must be also positioned on the tire so that they are not obstructed by the flange of any rim designated for use with that tire in this standard or in Standard No. 110 (§571.110 of this part).

S5.5.6 For LT tires, the maximum permissible inflation pressure shown must be the inflation pressure that corresponds to the maximum load of the tire for the tire size as specified in one of the publications described in S4.1.1.(b) of §571.139. At the manufacturer's option, the shown inflation pressure may be as much as 10 psi (69 kPa) greater than the inflation pressure corresponding to the specified maximum load.

*S6. Test procedures, conditions and performance requirements.* Each tire shall meet all of the applicable requirements of this section when tested according to the conditions and procedures set forth in S5 and S6.1 through S6.7.

S6.1. Tire dimensions

*S6.1.1 Test conditions and procedures.*

*S6.1.1.1 Tire Preparation.*

S6.1.1.1.1 Mount the tire on the measuring rim specified by the tire manufacturer or in one of the publications listed in S4.1.1

S6.1.1.1.2 For passenger car tires, inflate to the pressure specified in the following table:

Inflation pressure (kPa)	
Standard	Reinforced
180 .....	220

S6.1.1.1.3 In the case of a LT tire, inflate it to the pressure at maximum load as labeled on sidewall.

S6.1.1.1.4 Condition the assembly at an ambient room temperature of 20 °C to 30 °C for not less than 24 hours.

S6.1.1.1.5 Readjust the tire pressure to that specified in S6.1.1.2.

*S6.1.1.2 Test procedure.*

S6.1.1.2.1 Measure the section width and overall width by caliper at six points approximately equally spaced around the circumference of the tire, avoiding measurement of the additional thickness of the special protective ribs or bands. The average of the

measurements so obtained are taken as the section width and overall width, respectively.

S6.1.1.2.2 Determine the outer diameter by measuring the maximum circumference of the tire and dividing the figure so obtained by  $\pi$  (3.14).

S6.1.2 *Performance Requirements.* The actual section width and overall width for each tire measured in accordance with S6.1.1.2 shall not exceed the section width specified in a submission made by an individual manufacturer, pursuant to S4.1.1(a) or in one of the publications described in S4.1.1(b) for its size designation and type by more than:

(a) (For tires with a maximum permissible inflation pressure of 32, 36, or 40 psi) 7 percent, or

(b) (For tires with a maximum permissible inflation pressure of 240, 280, 300, 340 or 350 kPa) 7 percent or 10 mm (0.4 inches), whichever is larger.

S6.2 High Speed Performance

S6.2.1 *Test conditions and procedures.*

S6.2.1.1 *Preparation of tire.*

S6.2.1.1.1 Mount the tire on a test rim and inflate it to the pressure specified for the tire in the following table:

Tire application	Test pressure (kPa)
Passenger car tires:	
Standard load .....	220
Extra load .....	260
Light truck tires with a nominal cross section $\leq 295$ mm (11.5 inches):	
Load Range C .....	320
Load Range D .....	410
Load Range E .....	500
Light truck tires with a nominal cross section $> 295$ mm (11.5 inches)	
Load Range C .....	230
Load Range D .....	320
Load Range E .....	410

S6.2.1.1.2 Condition the assembly at 32 to 38 °C for not less than 3 hours.

S6.2.1.1.3 Before or after mounting the assembly on a test axle, readjust the tire pressure to that specified in S6.2.1.1.1.

S6.2.1.2 *Test procedure.*

S6.2.1.2.1 Press the assembly against the outer face of a test drum with a diameter of 1.70 m  $\pm 1\%$ .

S6.2.1.2.2 Apply to the test axle a load equal to 85% of the tire's maximum load carrying capacity.

S6.2.1.2.3 Break-in the tire by running it for 2 hours at 80 km/h.

S6.2.1.2.4 Allow tire to cool to 38 °C and readjust inflation pressure to applicable pressure in 6.2.1.1.1 immediately before the test.

S6.2.1.2.5 Throughout the test, the inflation pressure is not corrected and the test load is maintained at the value applied in S6.2.1.2.2.

S6.2.1.2.6 During the test, the ambient temperature, measured at a distance of not less than 150 mm and not more than 1 m from the tire, is maintained at not less than 32 °C or more than 38 °C.

S6.2.1.2.7 The test is conducted, continuously and uninterrupted, for ninety minutes through three thirty-minute consecutive test stages at the following speeds: 140, 150, and 160 km/h.

S6.2.1.2.8 Allow the tire to cool for between 15 minutes and 25 minutes. Measure its inflation pressure. Then, deflate the tire, remove it from the test rim, and inspect it for the conditions specified in S6.2.2(a).

S6.2.2 Performance requirements. When the tire is tested in accordance with S6.2.1:

(a) There shall be no visual evidence of tread, sidewall, ply, cord, innerliner, belt or bead separation, chunking, open splices, cracking, or broken cords.

(b) The tire pressure, when measured at any time between 15 minutes and 25 minutes after the end of the test, shall not be less than 95% of the initial pressure specified in S6.2.1.1.1.

S6.3 Tire Endurance

S6.3.1 *Test conditions and procedures.*

S6.3.1.1 *Preparation of Tire.*

S6.3.1.1.1 Mount the tire on a test rim and inflate it to the pressure specified for the tire in the following table:

Tire application	Test pressure (kPa)
Passenger car tires:	
Standard load .....	180
Extra load .....	220
Light truck tires with a nominal cross section $\leq 295$ mm (11.5 inches)	
Load Range C .....	260
Load Range D .....	340
Load Range E .....	410
Light truck tires with a nominal cross section $> 295$ mm (11.5 inches)	
Load Range C .....	190
Load Range D .....	260
Load Range E .....	340

S6.3.1.1.2 Condition the assembly at 32 to 38 °C for not less than 3 hours.

S6.3.1.1.3 Readjust the pressure to the value specified in S6.3.1.1.1 immediately before testing.

*S6.3.1.2 Test Procedure.*

S6.3.1.2.1 Mount the assembly on a test axle and press it against the outer face of a smooth wheel having a diameter of 1.70 m  $\pm$  1%.

S6.3.1.2.2 During the test, the ambient temperature, at a distance of not less than 150 mm and not more than 1 m from the tire, is maintained at not less than 32 °C or more than 38 °C.

S6.3.1.2.3 Conduct the test, without interruptions, at the test speed of not less than 120 km/h with loads and test periods not less than those shown in the following table. For snow tires, conduct the test at not less than 110 km/h.

Test period	Duration (hours)	Load as a percentage of tire maximum load rating
1 .....	4	85
2 .....	6	90
3 .....	24	100

S6.3.1.2.4 Throughout the test, the inflation pressure is not corrected and the test loads are maintained at the value corresponding to each test period, as shown in the table in S6.3.1.2.3.

S6.3.1.2.5 Allow the tire to cool for between 15 minutes and 25 minutes after running the tire for the time specified in the table in S6.3.1.2.3, measure its inflation pressure. Inspect the tire externally on the test rim for the conditions specified in S6.3.2(a).

S6.3.2 Performance requirements. When the tire is tested in accordance with S6.3.1:

(a) There shall be no visual evidence of tread, sidewall, ply, cord, belt or bead separation, chunking, open splices, cracking or broken cords.

(b) The tire pressure, when measured at any time between 15 minutes and 25 minutes after the end of the test, shall not be less than 95% of the initial pressure specified in S6.3.1.1.1.

S6.4 Low Inflation Pressure Performance

*S6.4.1 Test conditions and procedures.*

*S6.4.1.1 Preparation of tire.*

S6.4.1.1.1 This test is conducted following completion of the tire endurance test using the same tire and rim

assembly tested in accordance with S6.3 with the tire deflated to the following appropriate pressure:

Tire application	Test pressure (kPa)
Passenger car tires.	
Standard load .....	140
Extra load .....	160
Light truck tires with a nominal cross section $\leq$ 295 mm (11.5 inches)	
Load Range C .....	200
Load Range D .....	260
Load Range E .....	320
Light truck tires with a nominal cross section $>$ 295 mm (11.5 inches)	
Load Range C .....	150
Load Range D .....	200
Load Range E .....	260

S6.4.1.1.2 After the tire is deflated to the appropriate test pressure in S6.4.1.1.1 at the completion of the endurance test, condition the assembly at 32 to 38 °C for not less than 2 hours.

S6.4.1.1.3 Before or after mounting the assembly on a test axle, readjust the tire pressure to that specified in S6.4.1.1.1.

*S6.4.1.2 Test procedure.*

S6.4.1.2.1 The test is conducted for ninety minutes at the end of the test specified in S6.3, continuous and uninterrupted, at a speed of 120 km/h (75 mph). For snow tires, conduct the test at not less than 110 km/h.

S6.4.1.2.2 Press the assembly against the outer face of a test drum with a diameter of 1.70 m  $\pm$  1%.

S6.4.1.2.3 Apply to the test axle a load equal to 100% of the tire's maximum load carrying capacity.

S6.4.1.2.4 Throughout the test, the inflation pressure is not corrected and the test load is maintained at the initial level.

S6.4.1.2.5 During the test, the ambient temperature, at a distance of not less than 150 mm and not more than 1 m from the tire, is maintained at not less than 32 °C or more than 38 °C.

S6.4.1.2.6 Allow the tire to cool for between 15 minutes and 25 minutes. Measure its inflation pressure. Then, deflate the tire, remove it from the test rim, and inspect it for the conditions specified in S6.4.2(a).

S6.4.2 Performance requirements. When the tire is tested in accordance with S6.4.1:

(a) There shall be no visual evidence of tread, sidewall, ply, cord, innerliner,

belt or bead separation, chunking, open splices, cracking, or broken cords, and

(b) The tire pressure, when measured at any time between 15 minutes and 25 minutes after the end of the test, shall not be less than 95% of the initial pressure specified in S6.4.1.1.1.

*S6.5 Tire strength.*

*S6.5.1 Tire strength for passenger car tires.* Each tire shall comply with the requirements of S5.3 of §571.109.

*S6.5.2 Tire strength for LT tires.* Each tire shall comply with the requirements of S7.3 of §571.119.

*S6.6 Tubeless tire bead unseating resistance.* Each tire shall comply with the requirements of S5.2 of §571.109. For light truck tires, the maximum permissible inflation pressure to be used for the bead unseating test is as follows:

Load Range C .....	260 kPa.
Load Range D .....	340 kPa.
Load Range E .....	410 kPa.

For light truck tires with a nominal cross section greater than 295 mm (11.5 inches), the maximum permissible inflation pressure to be used for the bead unseating test is as follows:

Load Range C .....	190 kPa.
Load Range D .....	260 kPa.
Load Range E .....	340 kPa.

*S7. Phase-in schedule for tire markings.*

*S7.1 Tires manufactured on or after September 1, 2005 and before September 1, 2006.* For tires manufactured on or after September 1, 2005 and before September 1, 2006, the number of tires complying with S4, S5.5, S5.5.1, S5.5.2, S5.5.3, S5.5.4, S5.5.5, and S5.5.6 of this standard must be equal to not less than 40% of the manufacturer's production during that period.

*S7.2 Tires manufactured on or after September 1, 2006 and before September 1, 2007.* For tires manufactured on or after September 1, 2006 and before September 1, 2007, the number of tires complying with S4, S5.5, S5.5.1, S5.5.2, S5.5.3, S5.5.4, S5.5.5, and S5.5.6 of this standard must be equal to not less than 70% of the manufacturer's production during that period.

*S7.3 Tires manufactured on or after September 1, 2007.* Each tire must comply with S4, S5.5, S5.5.1, S5.5.2, S5.5.3,

S5.5.4, S5.5.5, and S5.5.6 of this standard.

[67 FR 69627, Nov. 18, 2002, as amended at 68 FR 38150, June 26, 2003; 69 FR 31319, June 3, 2004; 71 FR 886, Jan. 6, 2006; 72 FR 49211, Aug. 28, 2007; 73 FR 72358, Nov. 28, 2008; 77 FR 760, Jan. 6, 2012; 86 FR 48545, Aug. 31, 2021; 87 FR 34810, June 8, 2022]

**§571.141 Standard No. 141; Minimum Sound Requirements for Hybrid and Electric Vehicles.**

*S1. Scope.* This standard establishes performance requirements for pedestrian alert sounds for motor vehicles.

*S2. Purpose.* The purpose of this standard is to reduce the number of injuries that result from electric and hybrid vehicle crashes with pedestrians by providing a sound level and sound characteristics necessary for these vehicles to be detected and recognized by pedestrians.

*S3. Application.* This standard applies to—

(a) Electric vehicles with a gross vehicle weight rating (GVWR) of 4,536 Kg or less that are passenger cars, multi-purpose passenger vehicles, trucks, or buses;

(b) Hybrid vehicles with a gross vehicle weight rating (GVWR) of 4,536 Kg or less that are passenger cars, multi-purpose passenger vehicles, trucks, or buses; and

(c) Electric vehicles and hybrid vehicles that are low speed vehicles.

*S4. Definitions.* *Band* or *one-third octave band* means one of thirteen one-third octave bands having nominal center frequencies ranging from 315 to 5000Hz. These are Bands 25 through 37 as defined in Table A1, Mid-band Frequencies for One-Third-Octave-Band and Octave-Band Filters in the Audio Range, of ANSI S1.11–2004: “Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters” (incorporated by reference, see §571.5).

*Band sum* means the combination of Sound Pressure Levels (SPLs) from selected bands that produce an SPL representing the sound in all of these bands. Band sum is calculated with the following equation: